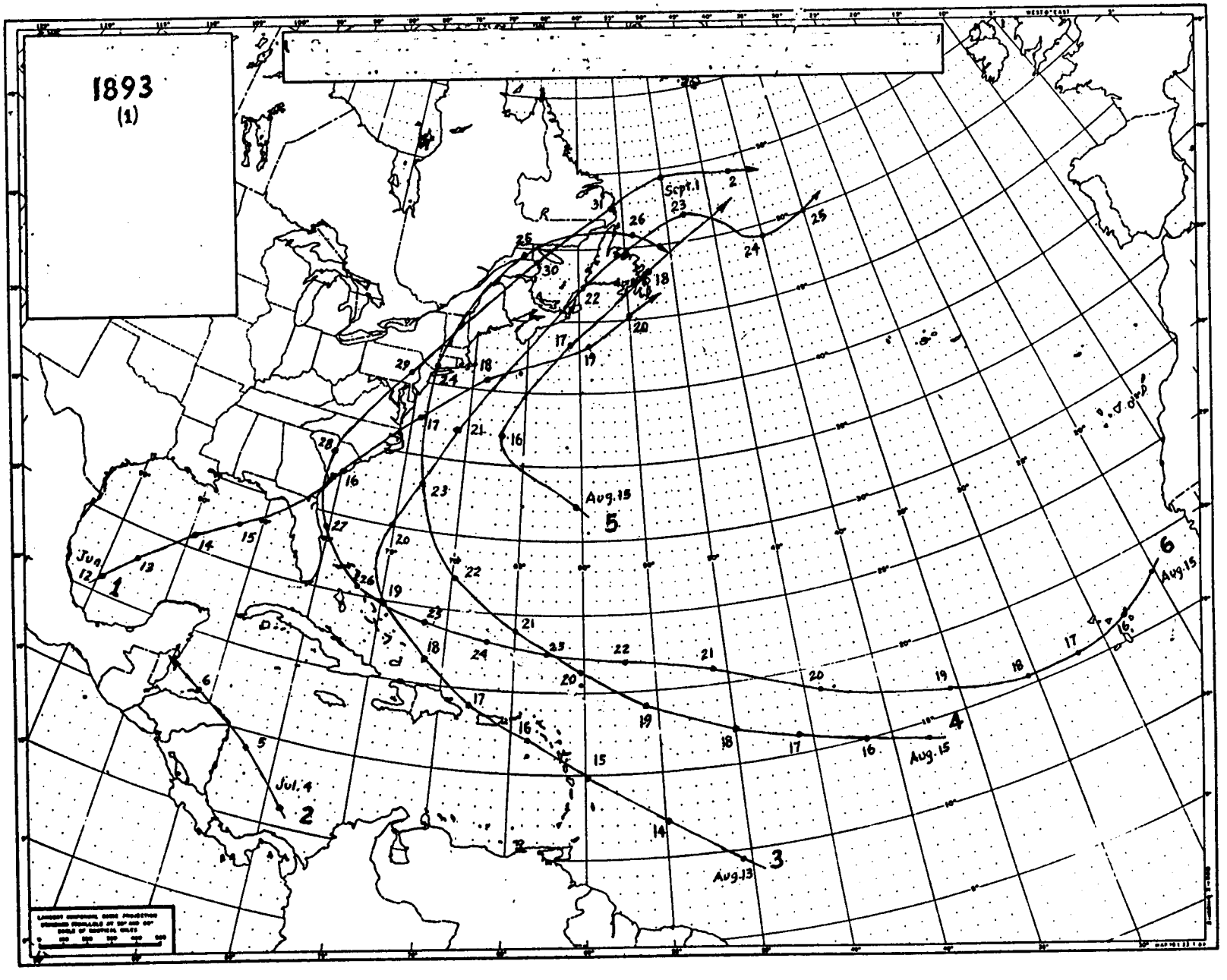

Fig. 3

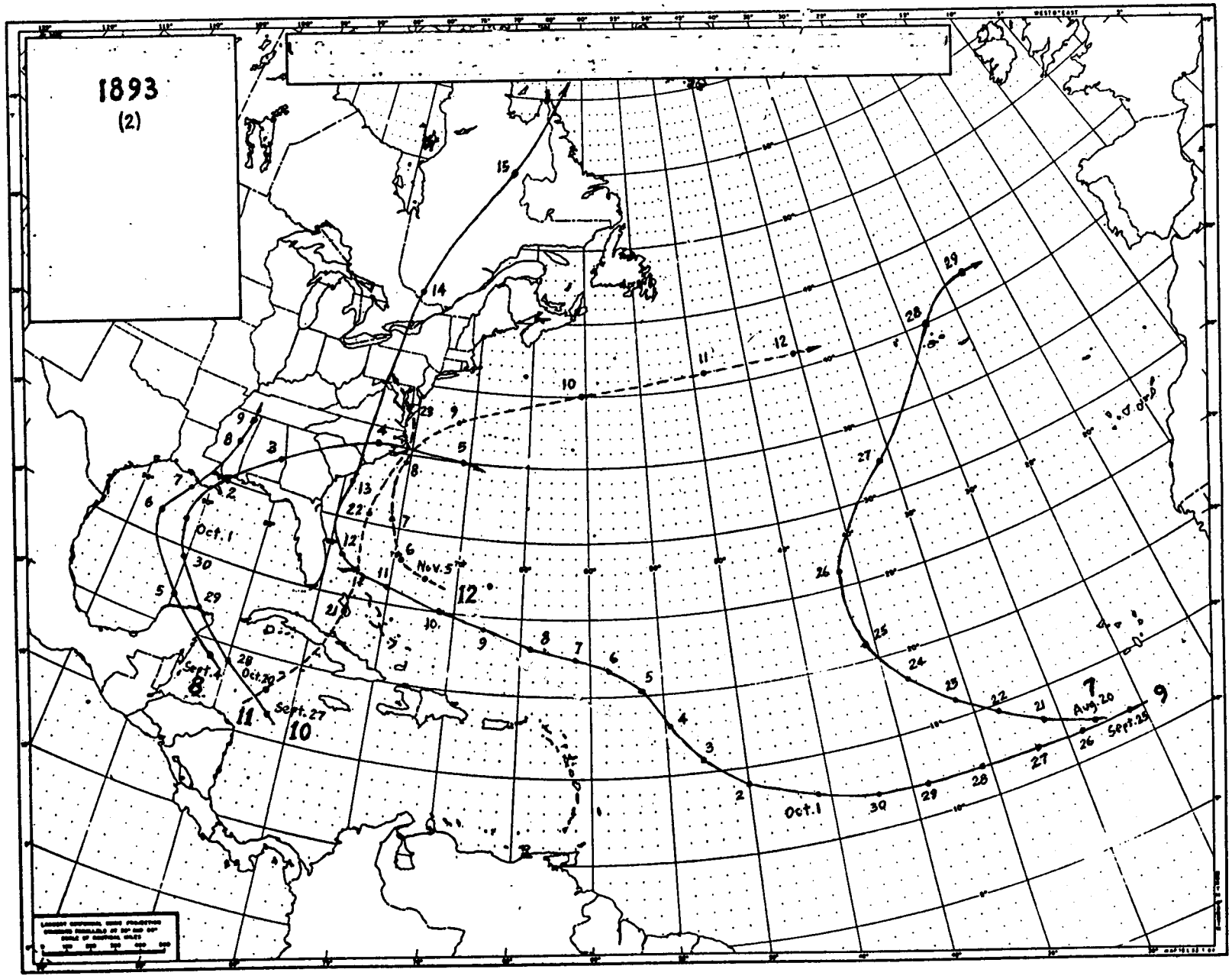

Fig.3 (continued)

long. 76.7 W.; Aug. 27, lat. 29 N., long. 80.5 W.; Aug. 28, lat.33.7 N., long. 81.7 W.; Aug. 29, lat. 43.3 N., long. 76 W.; Aug. 30, lat. 48.5 N., long. 64 W.; Aug. 31, lat. 51.5 N., long. 50 W. (Monthly Weather Review, Aug. 1893). 33) An Aug. 1893 storm appeared at lat. 22 N., long. 57 W., recurved at lat. 27 N., long. 77 W. and disappeared N.E. of Newfoundland (Garriott, 1900). Author's note: The recurvature at lat. 27 N., long. 77 W. is obviously incorrect. 34) A storm was first observed at lat. 15 N., long. 30 W on Aug. 18 and lasted 20 days; it recurved at lat. 34 N., long. 81 W. and it was last observed at lat. 66 N., long. 20 E. (Mitchell, 1924). Author's note: A track which is also given in Mitchell (1924) was found to start 3 days later and nearly 600 miles to the W.S.W. of the one in Neumann et al.(1993). While the latter track brings the storm over the northern Bahamas, the one in Mitchell (1924) keeps it at a good distance to the N.E. of those islands.

On the basis of information in items 1) and 34), any track for Storm 6, 1893 east of about the 55 degrees W. meridian seems to be a matter of speculation; nevertheless, the author of this study decided to keep unchanged the track in Neumann et al. (1993) for the period Aug. 15-21. The remaining of the track (Aug. 22- Sept. 2) in the above mentioned publication was found to be supported, in general, by the abundant information which is contained in the 34 items above. Therefore, the entire track for Storm 6, 1893 in Neumann et al. (1993) was reproduced in Fig. 3.

The hurricane status which Neumann et al. (1993) gave to this storm was easily verified by the content of many of the items above. In fact, Storm 6, 1893 was found to be a major hurricane as a minimum pressure of about 28.30 inches was reported at Savannah (items 11 and 12).

Storm 7, 1893 (Aug. 20-29), H.

Very little information was found about this storm: 1) London, Sept. 2. A hurricane passed over the Azores Islands on Aug. 28. Two vessels were wrecked at the harbor of Fayal and 14 houses were destroyed in the town. At Terceira 3 vessels were wrecked and 28 houses were destroyed. Five persons were killed. (The New York Times, Sept. 3, 1893, p.1, col.4). 2) A hurricane is said to have passed over the Azores on Aug. 23, doing great damage, but the marine reports give no intimation of such a storm and it may have been only a short-lived whirlwind (Monthly Weather Review, Aug. 1893). Author's note: The storm reported to have occurred at the Azores on Aug. 23 might have actually been the one of Aug. 28. In this case, the date of Aug. 23 should be corrected to read Aug. 28. 3) A storm was first observed at lat. 12 N., long. 28 W. on Aug. 20, 1893 and lasted 9 days; it recurved at lat. 26 N., long 41 W. and it was last observed at lat. 41 N., long. 19 W. (Mitchell, 1924). Author's note: A track for this storm which is displayed in Mitchell (1924) is quite similar to the one in Neumann et al. (1993).

Information in the above items was found to support the track in Neumann et al. (1993) and, therefore, such a track was reproduced in Fig. 3.

The hurricane status which was attributed to Storm 7, 1893 by the above authors was found to agree with information in item 1).

Storm 8, 1893 (Sept. 4-9), H.

The following information was found in relation to this storm: 1) This storm in the Gulf of Mexico evidently existed on the morning of Sept. 5, at which time pressure was diminishing at the Gulf coast, but no marine reports are at hand to locate the center more exactly. The increasing N.E. winds on the Louisiana and Texas coasts showed that a hurricane was moving northward on Sept. 6. During Thursday, Sept. 7, the center moved over the southern portion of Louisiana, doing much damage over a small area, but rapidly breaking up as it moved inland. The course of the center was quite irregular. On the afternoon of Sept. 8 it was central in southeastern Alabama and the area of revolving winds and rain remained south of Tennesse until Sept. 11, by which time pressure had become nearly normal and the storm center had disappeared (Monthly Weather Review, Sept. 1893). 2) Washington, Sept. 5, 8 P.M. A slight disturbance appears to be developing in the West Gulf, a maximum wind of 32 mph being reported at Galveston. Rain has fallen on the West Gulf coast (The New York Times, Sept. 6, 1893, p.5, col.6). 3) Washington, Sept. 6, 8 P.M. A storm in the West Gulf appears to be gaining in intensity, a wind of 38 mph being reported at Galveston. Signals are displayed in the Gulf from Corpus Christi to Pensacola (The New York Times, Sept. 7, 1893, p.5, col.6). 4) Washington, Sept. 7, 8 P.M. The storm in the Gulf has moved northward to New Orleans, the pressure having fallen 0.42 inch in 24 hours at that place, causing a steep gradient in the N.E. semicircle (The New York Times, Sept. 8, 1893, p.8, col.5). 5) The storm in southeastern Louisiana moved N.E. to western Alabama. Signals are displayed from Mobile to Pensacola (The New York Times, Sept. 9, 1893, p.5, col.7). 6) Washington, Sept. 9, 8 P.M. The storm moved from southern Mississippi to northern Mississippi (The New York Times, Sept. 10, 1893, p.8, col.6). 7) Washington, Sept. 10, 8 P.M. The storm has remained nearly stationary in Mississippi, diminishing in energy (The New York Times, Sept. 11, 1893, p.5, col.6). 8) Maximum wind velocities were as follows: Galveston, N.E. 42 mph on Sept. 6; New Orleans, 36 mph on Sept. 7; Vicksburg, S.E. 30 mph on Sept. 6; Port Eads, S.W. 34 mph on Sept. 8; Mobile, N.E. 36 mph on Sept. 8; Montgomery, E. 26 mph on Sept. 8; Meridian, N.E. 24 mph on Sept. 8 (Monthly Weather Review, Sept. 1893). 9) Storm of Sept. 7-8, 1893. Louisiana. Minimal. Much damage in small area (Dunn and Miller, 1960). 10) Storm of Sept. 6-10, 1893. Gulf of Mexico (Tannehill, 1938). 11) A storm track as follows: Sept. 6 (morning), lat. 26 N., long. 93 W.; Sept. 6 (evening), lat. 27.5 N., long. 94.5 W.; Sept. 7 (morning), lat. 28.5 N., long. 92.5 W.; Sept. 7 (evening), lat. 29.7 N., long. 91 W.; Sept. 8 (morning), lat. 31 N., long. 91 W.; Sept. 8 (evening), lat. 32 N., long. 88.7 W.; Sept. 9 (morning), lat. 33 N., long. 89 W.; Sept. 9 (evening), lat. 34 N., long. 90.7 W.; Sept. 10 (morning) lat. 33.5 N., long. 89.5 W.; Sept. 10 (evening), lat 32.5 N., long. 90 W. (Monthly Weather Review, Sept. 1893). 12) Map showing a track for a Sept. 1893 storm starting near lat. 27 N., long. 93 W. on Sept. 6, and

continuing to near lat. 29 N., long. 92 W. on Sept. 7, to near lat. 31 N., long. 90.5 W. on Sept. 8 and then meandering over northern Mississippi on Sept. 10-11 (Garriott, 1900). 13) A storm was first observed near lat. 24 N., long. 93 W. on Sept. 6, 1893 and lasted 4 days; it recurved near lat. 26 N., long. 93 W. and it was last observed near lat. 34 N., long. 89 W. (Mitchell, 1924). Author's note: With the exception that this track was started 2 days later than the one in Neumann et al. (1993), both tracks were found to be quite similar.

Although some informattion in the above items suggested a more complicated track for Storm 8, 1893 than the one shown by Neumann et al. (1993) and the extension of the track to Sept. 10, the author of this study decided to keep their entire track unchanged. His decision was made because of the large uncertainties which were expected to be associated with the positioning of a weakening weather system, particularly in years as far back as 1893. Consequently, the above mentioned track was reproduced by him in Fig. 3.

Based on the great damage produced by the storm over a small area (items 1 and 9), the author of this study believes that Storm 8, 1893 was a hurricane having a short radius and that, therefore, the hurricane status which Neumann et al. (1993) gave to the storm showed to be correct.

Storm 9, 1893 (Sept. 25- Oct. 15), H.

Abundant information was found about this storm: 1) The reports from the "Ida" show a high sea Oct. 1-3 from the S.E., with gloomy weather at about lat. 15 N., long. 43 to 45 W. (Monthly Weather Review, Oct. 1893). Author's note: This information was apparently taken from Lake Storm Bulletin No. 2 of 1893 and its author located the center at noon Oct. 1 (Greenwich time) at, approximately, lat. 18 N., long. 45 W., after discarding the S.E. seas reported by the "Ida". 2) Reports from the "Catalonia" show that a disturbance prevailed on Oct. 3-4 in lat. 19 to 20 N., long. 48 to 50 W. (Monthly Weather Review, Oct. 1893). Author's note: A storm position near lat. 18 N., long. 49 W. was given for noon Oct. 5 (Greenwich time) after indicating that the "Catalonia" was near the center at that time. 3) The "John B. Coyle" was near the center from noon Oct. 6 to 3 A.M. Oct. 7. (Monthly Weather Review, Oct. 1893). Author's note: Based on the above information, somebody estimated the noon Oct. 7 (Greenwich time) storm position at lat. 21 N., long. 58 W. which is given in the Monthly Weather Review, Oct. 1893. 4) Government Laboratory, Saint John, Antigua. Barometer (corrected and reduced): Sept. 30, 29.94 inches but fell steadily to 29.70 inches on Oct. 5, and to 29.68 inches on Oct. 6, the wind from S.W. force 3 to 4; minimum barometer 29.66 inches at 3 P.M., wind S.W. force 6, and pressure stayed low throughout Oct. 7, wind S.S.W. force 6 diminishing to 4. Barometer then rose to 29.98 inches by Oct. 12. During Oct. 6 the sky covered with thin haze (Monthly Weather Review, Oct. 1893). 5) Government House, Roseau. Dominica. Ever since Oct. 1 most unusual weather, very hot, light N. winds, highly colored sunsets, no rain, abnormally low barometer steadily falling to a minimum of 29.77 inches on Oct. 6 (Monthly

Weather Review, Oct. 1893). 6) Washington, Oct. 6, 8 P.M. A report from Antigua dated 6 A.M. Oct. 6 gave barometer of 29.69 inches, clearing and a W. wind of 32 mph. A heavy swell from S.E. is reported from the Carolina coast this evening (The New York Times, Oct. 7, 1893, p.5, col.6). 7) The observer at Santiago de Cuba states that the hurricane was N.N.E. of St. Thomas in the morning of Oct. 7 (Monthly Weather Review, Oct. 1893). 8) Washington, Oct. 8, 8 P.M. The barometer continues generally high over the S.E. States , except over the Florida peninsula where it is 6 to 8 tenths of an inch (it should read hundredths of an inch) below normal (The New York Times, Oct. 9, 1893, p.5, col.6). 9) Washington, Oct. 9, 8 P.M. A report from Santiago de Cuba dated at midnight Oct. 8 (to Oct. 9) reported a brisk N.N.E. wind attending a cyclonic disturbance to the S.S.E. of that place. The influence of this storm will probably be felt over the Florida peninsula Tuesday (Oct. 10). This morning a heavy E. swell was reported at Highland Light, Ma. and a swell at Long Branch, N.J., with light S.W. to W. winds (The New York Times, Oct. 10, 1893, p.5, col. 6). Author's note: The midnight Oct. 8-9 position of the disturbance to the S.S.E. of Santiago de Cuba was erroneous. 10) According to information in Lake Bulletin No. 2, by the evening of Oct. 9 the storm approach was indicated by reports from Nassau (Bahamas) and southern Florida. On the morning of Oct. 10 brisk to high northerly winds were reported at Nassau, and signals for N.E. gales were ordered (Monthly Weather Review, Oct. 1893). 11) The "Muriel" left San Juan on Oct. 4. One week later (Oct. 11) the vessel was doing what she could to keep her deck over water. It was the edge of a hurricane. And when the full force of the storm was felt the decks were almost constantly under water. For 56 hours the storm lasted. Two days later, at dusk a sail was reported ahead. It proved to be the brigantine "Hattie Z. Rich". It was dark and the vessel was setting a flag which was union down as a signal of distress. The "Muriel" picked up the crew as soon as they abandoned the "Rich", which had left Turk Islands Oct. 2 for Eastport, Me. (The New York Times, Oct. 26, 1893, p.1, col.1). 12) The survivors of the "Vera Cruz" were brought to New York by the steamship "Antila". The "Vera Cruz" left Laguna, Mexico, for Hamburg and encountered a N.E. hurricane while off Bahamas on Oct. 11 (The New York Times, Oct. 26, 1893, p.1, col.1). 13) Nassau, N.P., Oct. 17. The hurricne which passed over this island Oct. 11 left considerable damage in its wake. The devastation of the wind was such as to force the water into the harbor and the sea rose rapidly until East and West Bay Streets were submerged. The waves swept over the west end of Hog Island, carrying away the assistant lightkeeper's residence from its foundation and washing it into the harbor, the force of the sea drifting it, like a huge buoy, against the southern shore, half a mile away. At Abaco plantations were devastated and many buildings blown down. At Eleuthera the force of the storm was felt severely and damage was sustained at many of the pineapple cultivaations for which the island is noted (The New York Times, Oct. 29, 1893, p.21, col.5). 14) Washington, Oct. 10, 8 P.M. The West Indian storm is apparently approaching the Florida peninsula from eastern Cuba (The New York Times, Oct. 11, 1893, p.5, col.5). Author's note: Actually the storm was not coming from eastern Cuba

but from the Bahamas. 15) On the morning of Oct. 11 the storm was apparently central E. of the Bahamas and the barometer was falling over the Bahamas and at Jupiter (Monthly Weather Review, Oct. 1893). 16) M Carmera, captain of the steamer "Ciudad Condal" reports the presence of his vessel in the neighborhood of the hurricane center on Oct. 11-12. Tne noon positions for the vessels were as follows: Oct. 11, lat. 25 57 N., long. 79 59 W.; Oct. 12, lat. 27 16 N., long. 79 41 W.; Oct. 13, lat. 27 20 N., long. 79 05 W. At 9 P.M. Oct. 11, the barometer read 748 millimeters (29.45 inches) after being corrected for temperature of 24 degrees C, and the wind was N.N.W. force 9. At 4 A.M. Oct. 12, the barometer was 740 millimeter (29.13 inches) and the wind was N.N.W. force 11. At 4 P.M. Oct. 13 (it should read Oct. 12) the barometer read 729 millimeters (28.70 inches) and the wind was S.W. force 11. The maximum velocity of the wind was about 80 mph (Monthly Weather Review, Oct. 1893). Author's note: The noon Oct. 13 position reported by the "Ciudad Condal" seems to be too far south. The vessel was on her way from Havana to New York, and the captain estimated that the center of the hurricane was 70 miles to the E.N.E. of the ship at 9 P.M. Oct. 11, 50 miles to the E. at 4 A.M. Oct. 12 and 30 miles to the S.E. at 4 P.M. Oct. 13 (it should read Oct. 12). Obviously, the storm center must have been to the N.N.W. or N. and not the S.E. of the ship at the latter time. 17) Washington, Oct. 11, 8 P.M. The West Indian cyclone will probably reach the South Atlantic coast Thursday (Oct. 12) attended by destructive wind storms (The New York Times, Oct. 12, 1893, p.1, col.3). 18) At Jupiter, Fl., rapidly falling barometer and N. winds backing to N.W. began on Oct. 11. The wind reached a maximum velocity of 72 mph. from the W. from midnight (Oct. 11-12) to 2 A.M. Oct 12. Heavy rain began at 9:25 P.M. Oct. 11 and ended at 1:22 P.M. Oct.12 (Monthly Weather Review, Oct. 1893). 19) The observer at Titusville reported that at 8 P.M. Oct. 11 the wind was blowing at a steady rate of 52 mph, with the maximum of 60 mph. At 12:05 A.M. Oct. 12 the anemometer cups were blown away and there were several heavy squalls during the night that must have been between 80 and 90 mph. The continued N. and N.W. winds drove the water back from the western shore of the Indian River farther than ever before, and at the end of the streamboat dock, the bed was perfectly dry for one-fourth of a mile (Monthly Weather Review, Oct. 1893). 20) Jacksonville, Oct. 12. The storm reached its height here at 2:15 P.M., the velocity of the wind being then 48 mph. This indicate that the damage here will be less severe than expected (The New York Times, Oct. 13, 1893, p.1, col.3). 21) At Jacksonville, on Oct. 11 at standard low tide the water was within 10 inches of the standard high tide; at 7 A.M. Oct. 12 the water had risen still higher and covered the sea wall of the central basin and at 8 A.M. was combing over the sea wall N. of Fort Marion; at 10:30 A.M. the water reached its highest point, 12 inches above the sea wall and the streets of St. Augustine were inundated. The gale continued unabated from the N. until 4 P.M.; the next regular high tide was at 11:30 P.M., but by 6 P.M. Oct. 12 the wind had veered to N.W. The heavy rain ceased at 9 P.M. (Monthly Weather Review, Oct. 1893). 22) Washington, Oct. 12, 8 P.M. The West Indian hurricane has moved slowly N.W. and is central

this evening E. of Jacksonville, attended by severe N.E. gales and heavy rain along the South Atlantic coast (The New York Times, Oct. 13, 1893, p.5, col.6). 23) Columbia, S.C., Oct. 12. The telegraphic communication with Charleston was completely cut off at 7 P.M. tonight. The last message received indicates the wind to be blowing 45 to 50 mph (The New York Times, Oct. 13, 1893, p.1, col.3). 24) Charleston, Oct. 13. The barometer reached its lowest point at 7:45 A.M. this morning, marking 28.90 inches. The wind attained a maximum speed of 60 mph at 9 P.M. last night. The rainfall for the 24 hours was 4.72 inches (The New York Times, Oct. 14, 1893, p.3, col.4). Author's note: Information included in Lake Storm Bulletin No. 2 and published in the Monthly Weather Review, Oct. 1893, indicated a barometer reading of 28.88 inches at Charleston at 6:45 A.M. Oct. 13, which is slightly lower than the one reported in the item above. 25) According to the Morning News (Savannah, Oct. 15, 1893), a low pressure of 28.40 inches was reported by the steamship "William Lawrence" on Oct. 13 between Frying Pan Shoals and Charleston. The hurricane passed over the Winyah Bay entrance and crossed the South Carolina coast near Myrtle Beach. At South Island, near Winyah Bay, the maximum wind recorded was 90 mph from the N.E. and a high tide of 9.3 feet above mean sea level was reported. Some barometer readings at South Island were: 4 A.M. Oct. 13, 29.30 inches; 6 A.M., 29.18 inches; 8 A.M., 28.95 inches; 10 A.M., 28.33 inches; noon, 28.95 inches; 2 P.M., 29.16 inches; 4 P.M. 29.30 inches. According to a letter by Gen. E. P. Alexander of Georgetown, S.C., an extract of which was reproduced in the Monthly Weather Review (Oct. 1893), the high water at the North Island lighthouse rose 10.3 feet above ordinary low water. The News and Courier (Charleston, Oct. 16, 1893) stated that at Pawley's Island the water rose 4 feet in ten minutes and reached fully 14 feet above the ordinary high water mark, leaping over the high sand hills and sweeping to destruction horses, cattle and animals of all kind. The Morning Star (Wilmington, Oct. 15, 1895) stated that at Magnolia Beach (a sandy peninsulta located just N. of Pawley's Island) almost every house was blown away and 19 people were drowned (Ho, 1989). Author's note: By using some hydrometeorological formulation, Ho (1989) estimated a central pressure about 28.20 inches when the storm made landfall on the South Carolina coast. 26) Wilmington, N.C. The storm arrived on time in accordance with the predictions of the Weather Bureau; the maximum velocity of the wind was 56 mph between 11 A.M. and 2 P.M. Oct. 13. At Southport the wind velocity reached 80 mph at 11:30 A.M. Oct. 13 (Monthly Weather Review, Oct. 1893). Author's note: The Monthly Weather Review, Oct. 1893, gave a second value of 94 mph for the maximum wind at Southport and Ho (1989) indicated that, according to the Weather Bureau station journal at Wilmington, very heavy gusts of only a few seconds duration caused high puffs which doubtless reached 75 or 80 mph. 27) Raleigh, N.C. The barometer began to fall rapidly during the early morning of Oct.13, and continued to fall until 3:20 P.M. when it read 28.67 inches. A gale began at 11 A.M. and continued to 7:30 P.M.; the most violent gusts occurred between 2 and 3 P.M. (Monthly Weather Review, Oct. 1893). 28) The evening report of Oct. 13 showed the storm central over northern North Carolina, the center having passed Lynchburg about

5 P.M., where a barometer reading of 28.88 inches was recorded. The center passed W. of Washington, D.C., about 9 P.M. and by the morning of Oct. 14 had crossed Pennsylvania and western New York, and was central N. of Lake Ontario, a barometer reading of 28.74 inches being reported at Toronto. During Oct. 15 the storm disappeared in the direction of Labrador (Monthly Weather Review, Oct. 1893). 29) New Haven, Conn., Oct. 13. About 8 P.M. tonight a heavy rainstorm came up and the wind blew at a rate of 25 mph, but it soon subsided and clearing weather followed (The New York Times, Oct. 14, 1893, p.3, col.4). 30) The liner "Paris" passed Fire Island bound in at 9:55 Friday night (Oct. 13). Before Sandy Hook was reached the gale had gathered such force that Capt. Radle concluded that it was wiser to subject his passengers to a little shaking up rather than to take the risk of crossing the bar while the storm was blowing. The "Paris" was accordingly headed to the eastward and laid on and off until the storm moderated (The New York Times, Oct. 15, 1893, p.2, col.5). 31) Wilmington, Oct. 14. The tide here measured 16 inches above the record of 1853. All the wharves were under water and the flood swept through the warehouses. At Southport, N.C., the Customs House and nearly all the wharves were washed away. At Oceanview, N.C., the large paviliions and many cottages were either swept away or badly damaged (The New York Times, Oct, 15, 1893, p.2, col.6). Author's note: Barnes (1995) also indicates that the overflowing tide in downtown Wilmington was reported to be the greatest ever, measuring 16 higher than the previous high mark established in 1853. 32) Washington, Oct. 14, 8 P.M. The West Indian hurricane central Friday evening over western Virginia has advanced N. of the St. Lawrence River attended by heavy rains and severe gales in the Middle Atlantic and New England States and the eastern lake region (The New York Times, Oct. 15, 1893, p.5, col.5). 33) Some maximum wind velocities were: Jupiter, W. 72 mph on Oct. 11; Titusville, N. 70 mph on Oct. 11; Jacksonville, N.W. 39 mph on Oct. 12; Savannah, N.W. 40 mph on Oct. 13; Charleston N.E. 60 mph on Oct. 12; Wilmington, S.E. 56 mph on Oct. 13; Southport, 94 mph on Oct. 13; Raleigh, E. 36 mph on Oct. 13; Kittyhawk, S.E. 56 mph on Oct. 13; Hatteras, S.E. 60 mph on Oct. 13; Charlotte, S.W. 32 mph on Oct. 13; Norfolk, S.E. 42 mph on Oct. 13; Washington, D.C., S.E. 42 mph on Oct. 13; Baltimore, S.E. 40 mphh on Oct. 13; Atlantic City, S.E. 44 mph on Oct. 13; Philadelphia, S.E. 55 pph on Oct. 13; Harrisburg, S. 48 mph on Oct. 14; New York, S.E. 48 mph on Oct. 14; Albany, S.E. 48 mph on Oct. 14; New London, S.E. 63 mph on Oct. 14; New Haven, S.E. 50 mph on Oct. 14; Woods Hole, S.E. 50 mph on Oct. 14; Boston, S. 49 mph on Oct. 14; Northfield, S. 60 mph on Oct. 14; Manchester S.E. 30 mph on Oct. 14 (Monthly Weather Review, Oct. 1893). 34) Galveston. The steamer "Palmas", from Tenerife, picked up and brought here 69 passengers and crew of the steamer "Marseille", from Bordeaux for New Orleans, which was totally lost in lat. 27 N., long. 70 W. (The Times, London, Oct. 20, 1893, p.8, col.6). Author's note: Although no date was given, The New York Times, Oct. 18, 1893, p.1, col.5, states that the wreck of the "Marseille" was probably related to severe weather. Therefore, it seems likely that this disaster occurred in relation to Storm 9, 1893. 35) Storm of Oct. 11-13, 1893. Major in Florida, the center

remaining offshore. Major in the Carolinas, 22 killed in N.C. Mininal in all sections of the Middle Atlantic coast (Dunn and Miller, 1960). 36) Storm of Sept. 25-Oct. 15, 1893. Cape Verde, Atlantic coast (Tannehill, 1938). 37) A track for the storm showing the following morning positions: Oct. 5, near lat. 20 N., long. 49 W.; Oct. 6, near lat. 21 N., long. 54 W.; Oct. 7, near lat. 21.7 N., long. 57 W.; Oct. 8, near lat. 22.5 N., long. 61.7 W.; Oct.9, near lat. 23.5 N., long. 66 W.; Oct. 10, near lat. 25 N., long. 70.5 W; Oct. 11, near lat. 26.3 N., long. 75 W.; Oct. 12, near lat. 27.7 N., long. 78.7 W.; Oct. 13, near lat. 33 N., long. 79.5 W.; Oct. 14, near lat. 46.5 N., long. 78 W.; Oct. 15, near lat. 52.3 N., long. 67.5 W. (Monthly Weather Review, Oct. 1893). 38) An Oct. 1893 storm appeared at lat. 21 N., long. 54 W., recurved at lat. 27 N., long. 79 W. and disappeared N. of Newfoundland. Map showing the storm to have been near lat. 22.5 N., long. 61.5 degrees W. on Oct.7; near lat. 23.5 N., long. 66.3 W on Oct. 8; near lat. 24 N., long. 70 W. on Oct. 9, near lat. 25 N., long. 73 W. on Oct. 10, near lat. 26.3 N., long. 76 W. on Oct. 11, near lat. 28 N., long. 79 W. on Oct. 12 and near lat. 33 N., long. 79.5 W. on Oct. 13 (Garriott, 1900). 39) A storm was first observed near lat. 11 N., long. 26 W. on Sept. 25, 1893 and lasted 22 days; it recurved near lat. 33 N., long. 75 W. and it was last observed near lat. 68 N., long. 49 W. (Mitchell, 1924). Author's note: As shown by a track included in Mitchell (1924), the recurvature location near lat. 33 N., long. 75 W. is erroneous because of a typographic mistake and should read lat. 33 N., long. 80 W. In addition, it was found that, roughly between the 60 degrees W. and the 77 degrees W. meridians, this track was 100-150 miles to the north of the one shown in Neumann et al. (1993).

Although information in the vast majority of the above items was found to support, in general, the track for Storm 9, 1893 in Neumann et al. (1993), a minor adjustment was made to their 7 A.M. Oct. 13 position in order to satisfy information in item 25) which indicated that the storm center passed very close to South Island around 10 A.M. Oct. 13 and made landfall on the South Carolina coast near Myrtle Beach. The author's 7 A.M. Oct. 13 position was estimated near 32.5 degrees N., 79.3 degrees W. and was a few miles to the S.E. of the corresponding one in Neumann et al. (1993). After having introduced this change, the author produced the track for Storm 9, 1893 which is shown in Fig. 3.

Much of the information above fully supported the hurricane status which Neumann et al. (1993) gave to this storm, and the barometer readings of 28.40 inches taken on board the "William Lawrence" and of 28.33 inches taken at South Island (item 25) supported major hurricane intensity.

Storm 10, 1893 (Sept. 27- Oct. 5), H.

The following information was found about this storm: 1) The observer at New Orleans reports: Oct. 1 a severe and destructive storm began about 6:30 P.M. continuing through the night. The storm was severest in the Louisiana Delta and the Plaquemenes Parish. A velocity of 48 mph was attendend in the city (New Orleans) at 8:20 P.M., after which the anemometer got out od order. A velocity of 65

mph was attained at West End, when the instrument became unserviceable (Monthly Weather Review, Oct. 1893) 2) Report from the Secretary of the Louisiana Weather Service: No complete record of the vind velocity can be obtained since all instruments in the path of the hurricane were blown down and in the case of Port Eads destroyed. The wind must have blown at a rate of 100 mph in the vicinity of Point-a-la-Hache and along the islands on the coast. It is probable that the center of the hurricane passed midway between New Orleans and Port Eads on a N.E. course, since the path of greatest destruction was in that neighborhood (Monthly Weather Review, Oct. 1893). 3) New Orleans, Oct. 3. The damage is much more serious than first reported. At Port Eads the quarantine steamer was wrecked. In the Parish of Plaquemenes, the villages Bohemia and Shell Beach were wiped out. On both sides of the river (Mississippi), the sugar, the rice and orange crops suffered great damage. The Grand Island- Fort Jackson train tonight brought 2 survivors from Bayou Cook. One of the survivors was in camp at Bayou Cook when the water came Sunday night (Oct. 1). The wind blew 150 mph and waves 15 feet high swept up the bayou. In Bayou Cook the settlements of fishermen were demolished and the loss of life has been placed at fully 200 (The New York Times, Oct. 4, 1893, p.1, col.5). 4) New Orleans, Oct. 4. There is no longer doubt that the islands Grand Isle and Cheniere Comenade have shared the fate of Last Island and that the tragedy of 1856 has been exceeded by the hurricane of Oct. 1. Mr. Scurb, a carpenter who was at Grand Isle and reached here today, said that the wind began blowing a gale at 7 P.M. Subday (Oct. 1). Waves 10 feet high swept over the north end of the island and encroached upon the high middle portion of it. At 9 P.M. there was an average depth (of water of 5 feet on the island. At midnight (Oct. 1-2) the inundation was 9 feet and the torrent was so powerful that nothing withstood before it. The wind reached its height about midnight and continued in severity for about 2 hours when it began to abate. At 4 A.M. Oct.2 it was blowing with only moderate intensity, finally dying out to a light breeze (The New York Times, Oct. 5, 1893, p.1, col.5). 5) New Orleans, Oct. 2. Ex-Governor Watmoth brought news tonight of the storm wind on the lower coast. The wind blew 120 mph devastating the fields, blowing the fruiis off the orange trees, damaging the sugar houses and demolishing a number of homes (The New York Times, Oct. 3, 1893, p.1, col.4). 6) Some obnservations along the path of the storm: At Caminadaville, a lull of 5 minutes, 20-ft tide; at Grand Isle, a lull of 15 minutes at 10:10 P.M. Oct. 1, wind shifted to N.W., island inundated to a depth of 6 feet above the highest ground; at Oyster Bayou and Adams Bay, 15-ft tide; at Bohemia, a calm period lasted 7 or 8 minutes, commencing at 1:30 A.M. Oct.2, wind shifted to northerly afterwards; at Porte-a-la- Hache maximum winds reached 100 mph shortly after midnight; at Chandeleur Islands maximum winds reached 100 mph (Ho, 1989). Author's note: Quoting a report by Graham and Hudson (1960), Ho (1989) indicated a central pressure estimate around 28.22 inches when the storm made landfall on the Mississippi coast. However, after considering some filling as the storm moved over the marshy terrain of the Mississippi Delta and applying some hydrometeorological formulation, Ho (1989) estimated a central pressure as low as 27.85 inches when the storm

was off Grand Isle. 7) Crossing Louisiana in a N.E. direction, the center struck the coast of Mississippi a little west of the Alabana boundary line. The following description by one who must have been very near the center is from Capt. Henry M. Davies of the schooner "B. Frank Neally" lying at anchor at Moss Point, Miss. (lat. 30 25 N., long. 88 34 W.): The vessel doubled lines at 5 A.M. Oct. 2; the wind came in gusts and rain 6 A.M.; carried away head lines and dropped anchor, glass at the time 29.30 inches; wind S.E. by E., time 7 A.M.; got a hawser from the starboard bow on shore. By the time the stern lines gave way, glass 29.00 inches. At 8 A.M. the vessel was riding to two hawsers from shore and one anchor, glass 28.85 inches, and the wind continued to blow heavier and heavier; glass 28.65 inches until 9:30 (90 degrees W. meridian time)), and it abated nearly to calm and gradually went around to S. and S.W. and it came out heavily from W.S.W. and W. at 11 A.M. and continued to 3 P.M. and cleared away. It never went N. of W. until some time during the night. Nearly calm at 8 P.M. (Monthly Weather Review, Oct. 1893). Author's note: Ho (1989) also listed the observations taken on board the above mentioned schooner and added that at Scranton (9 miles from the coast) the wind shifted to the S.W., welocity 80 mph, at 11 A.M. Oct. 2 and water rose 9 feet above high tide. 8) Mobile, Al., Oct. 2. A S.E. gale broke here this morning about 4 A.M. and the wind has been increasing in velocity ever since. The wind has blown the water in from the Gulf. All the wholesale and a great portion of the retail districts are 4 feet under water and thousands of dollar's worth of goods have been damaged. The bay boat "Heroine" was driven on the Mobile and Ohio wharf and was almost totally wrecked. The pilot boat "Ida Low" was driven on the wharf at the foot of St. Francis Street (The New York Times, Oct. 3, 1893, p.1, col.4). 9) Selected observations taken at Mobile: Oct. 2, 8 A.M., barometer 29.54 inches, wind 24 mph; 10 A.M., barometer 29.45 inches, wind 34 mph; noon, barometer 29.33 inches, wind 43 mph; 1 P.M., barometer 29.27 inches, wind 49 mph; 2 P.M., barometer 29.21 inches, wind 45 mph; 4 P.M., barometer 29.23 inches, wind 25 mph; 5 P.M., barometer 29.30 inches, wind 21 mph. Minimum pressure at Mobile for the month of Oct. 1893 was 29.10 inches and the maximum wind velocity for the same month was 72 mph (Ho, 1989). Author's note: It is obvious that the minimum pressure and the maximum wind velocity above were associated with this storm. 10) The observer at Mobile reports that rain began at 8:25 P.M. Oct. 1, with rapidly falling barometer and by 11 A,M. Oct. 2 a heavy S.E. gale was blowing. The extreme velocity of the wind several times reached 80 mph. At 2:15 P.M. the barometer began to rise and at 2:30 P.M. began to rise as rapidly as it had fallen. Great damage was done to property. The prostrated trees lay in one general direction from S.E. and S. The water was 4 inches higher than in 1852. Seven lives were reported lost (Monthly Weather Review, Oct. 1893). 11) The observer at Pensacola reports that on Oct. 3 (it should read Oct. 2) a severe storm struck that place about 4:45 A.M. Rain began at 5:20 A.M., accompanied by high winds, attaining a maximum welocity of 66 mph from S.W. at 3:45 P.M. From 6 to 10 A.M. the average hourly velocity was 34 mph and from 10 A.M. to noon, 40 mph were reported. Considerable damage was done, the greatest occurring along the water front. Railroad

communication was entirely cut off by the washouts and great damage was done to shipping (Monthly Weather Review, Oct. 1893). 12) Pensacola, Oct. 3. The storm of yesterday was the most destructive for 20 years. No loss of life has been reported but, on every street, uprooted trees, broken fences and roofless buildings testify of the storm's force (The New York Times, Oct. 4, 1893, p.1, col.5). 13) Mobile, Oct. 12. The U.S. Revenue steamer "Seaward" has reported to this port after an evenful cruise in the track of the recent Gulf storm. From officers of the "Seaward" it was learned that they rode the storm near Scranton, Miss, From midnight Oct. 1-2 to 4 P.M. Oct. 2 she encountered the full force of the storm. At 8 A.M. Oct. 2 the water at her anchorage had risen 13 feet above the normal. The wind was greater than they could calculate and the rain which accompanied it seemed to strike the face with the force of a hailstone (The New York Times, Oct. 13, 1893, p.1, col. 3). 14) Washington, Oct. 4, 8 P.M. The storm central over western South Carolina Tuesday night (Oct. 3) has passed off the Carolina coast attained by heavy rains in the Middle and South Atlantic States (The New York Times, Oct. 5, 1893, p.5, col.6). 15) The hurricane center moved slowly N.E. from Georgia to Cape Hatteras and seems to have been dissipated on Oct. 5 (Monthly Weather Review, Oct. 1893). Author's note: However, the storm might have existed for some more days in the Atlantic and be the same one encountered by the bark "Comorin", Hamburg to Bermuda, on Oct. 7-9 (The New York Times, Oct. 24, 1893, p.5, col.5). The "Comorin" developed a dangerous leak and was abandoned a week after the storm, the crew having been brought to New York by the bark "Angeli". No location was given for the bark-storm encounter. 16) Storm of Oct. 1-3. 1893. Extreme on the coastal areas of Louisiana, Mississippi and Alabama. 1000 to 2000 killed. Minor in the Pensacola area (Dunn and Miller, 1960). 17) Storm of Sept. 27- Oct. 6, 1893. Louisiana. Reached Gulf coast on Oct. 1-2. Wind estimated at 100 mph. Loss of life placed at 2000 (Tannehill, 1938). 18) Maximum wind velocities at some stations: New Orleans, N.E. 48 mph on Oct. 1; Pensaccola, S.W. 66 mph on Oct. 2; Mobile, S.E. 72 mph on Oct. 2; Montgomery, E. 36 mph on Oct. 2; Meridian, N. 28 mph on Oct. 2 (Monthly Weather Review, Oct. 1893). 19) Track showing, among others, the following positions: Oct. 1 (evening), lat. 29 N., long. 90.5 W.; Oct. 2 (morning), lat. 30.5 N., long 88.7 W.; Oct. 3 (morning), lat. 33 N., long. 86.5 W.; Oct. 4 (morning), lat. 36 N., long. 77 W.; Oct. 5 (morning), lat. 38.3 N., long. 67.3 W. (Monthly Weather Review, Oct. 1893). 20) A storm was first observed at lat. 16 N., long. 82 W. on Sept. 27, 1893 and lasted 7 days; it recurved at lat. 27 N., long. 91 W. and it was last observed at lat. 33 N., long. 74 W. (Mitchell, 1924). Author's note: Except for Oct. 5, a track which is also shown in Mitchell (1924) was found to be very similar to the one displayed in Neumann et al. (1993).

The track for Storm 10, 1893 in Neumann et al. (1993) over the period Oct. 1-5, was found to conform, in general, with information contained in the above items; however, owing to the lack of suitable information, the above mentioned track could not be checked prior to Oct. 1. Although on the basis of the author's note corresponding to item 15) there are some clues that the storm might have existed beyond Oct. 5, no attempt was made to extend the track

because daily positions could be inferred after that day. Therefore, the author of this study decided to accept the track in Neumann et al. (1993) and to reproduce it in Fig. 3.

The hurricane status which Neumann et al. (1993) attributed to the storm was fully supported by the content of a number of items. In fact, Storm 10, 1893 was found to be a major hurricane on the basis of information in items 3), 5), 13) and 16).

Storm 11, 1893 (Oct. 20-23), T.S.

The following information was found in relation to this storm: 1) On Oct. 19 pressure seems to have been somewhat low over the Caribbean Sea and a complete system of cyclonic winds existed near lat. 18 N., long. 82 W. on Oct. 20. On Oct. 21 it was at lat. 24 N., long. 78 W.; on Oct. 22 the wind circulated about a center at lat. 30 N., long. 79 W. The center moved rapidly northward becoming a gale on the North Carolina coast on Oct. 22; it then deviated a little to the west and dissipated in Mariland on Oct. 23 (Monthly Weather Review, Oct. 1893). 2) Washington, Oct. 21, 8 P.M. The storm moved E. of the Florida coast. It will cause high winds and dangerous squalls on the South Atlantic coast on Sunday, Oct. 22 (The New York Times, Oct. 22, 1893, p.2, col.6). Author's note: For several days this system was regarded as being in the Gulf, western Cuba or to the S. of Key West. Statements about the system were published in The New York Times, Oct. 18-21, 1893. 3) The "Muriel" was caught in a heavy E. blow off Barnegat on Monday (Oct. 23). According to Capt. Roblee, it was blowing a whole gale (The New York Times, Oct. 26, 1893, p.1, col.1). 4) Washington, Oct. 23, 8 P.M. The Atlantic storm has dissipated over the Middle Atlantic coast. E. gales have prevailed on the New Jersey and southern New England coasts attended by heavy rain. At 4 P.M. an unusually heavy E. swell was reported from Cape Henry and vessels that left port this morning are returning on account of the heavy weather at sea (The New York Times, Oct. 24, 1893, p.2, col.2). 5) Storm of Oct. 21-22, 1893. Minor in extreme southern Florida and the Carolinas. Inland S.W. of Hatteras (Dunn and Miller, 1960). 6) Storm of Oct. 20-23, 1893. Southern Florida, Middle Atlantic coast (Tannehill, 1938). 7) A storm track as follows: Oct. 21 (evening), lat. 27.3 N., long. 76 W.; Oct. 22 (morning), lat. 30.7 N., long. 76 W.; Oct. 22 (evening), lat. 36 N., long. 76.3 W.; Oct. 23 (morning), lat. 38.5 N. long. 76 W.; Oct. 23 (evenig), lat. 39.5 N, long. 78 W. (Monthly Weather Review, Oct. 1893). 8) A storm was first observed at lat. 23 N., long. 87 W. on Oct. 20, 1893 and lasted 3 days; it was last observed at lat. 40 N., long. 78 W. (Mitchell, 1924). Author's note: The corresponding track for Storm 11, 1893 in Mitchell (1924) made the storm to cross southern Florida during Oct. 21.

With the exception of information for Oct. 20-21 in item 8) and the corresponding author's note, the content of the above items was found to support the track for Storm 11, 1893 in Neumann et al. (1993). Therefore the author of this study decided to accept such a track and to reproduce it in Fig. 3. His action does not imply, however, that he fully agrees with the validity of the track and, as a matter of fact, he believes that, because neither Sarasola

(1928 nor Martinez-Fortun (1942) showed a storm in Cuba in Oct. 1893, there is a good possibility that the portion of the track to the south and across that island might be in error.

Information in the above items was found to support the tropical storm status which Neumann et al. (1993) gave to Storm 11, 1893.

Storm 12, 1893 (Nov. 5-12), T.S.

The following information was found in relation to this storm: 1) On Nov. 5-6 a low pressure was apparently moving westward towards Florida. A location can be approximately given at lat. 32 N., long. 75 W. in the afternoon of Nov.7. By the morning of Nov. 8 a well-defined disturbance was central near Cape Hatteras and on the evening of Nov. 9 the center was S.E. of Cape Cod. The center was near lat. 39 N., long. 55 W. on Nov. 10 and near lat. 41 N., long. 46 W. on Nov. 11 (Monthly Weather Review, Nov. 1893). 2) Washington, Nov. 8, 8 P.M. The storm which was central to the S.E. of Hatteras this morning is moving slowly N. and is now apparently central to the E. of Norfolk. Indications are that dangerous gales will prevail on the Middle Atlantic and southeastern New England coasts on Thursday morning, Nov. 9 (The New York Times, Nov. 9, 1893, p.5, col.7). 3) Stanford, Conn., Nov. 10. Fourtheen loaded coal barges were caught in a rough sea off here this morning. While floundering around, the towing hawsers parted and several of the barges filled and sank, drawing others with them until 10 of all have gone to the bottom (The New York Times, Nov. 11, 1893, p.1, col.2). 4) According to a report made yesterday by Capt. Mc Alpine of the bark "Clan Ferguson", a steamship whose name could not be distinguished was disabled by the gale of Friday (Nov. 10). The vessel was sighted by the officers of the bark during the height of the storm. Both vessels were then off the Delaware Breakwater (The New York Times, Nov. 13, 1893, p.1, col.6). Author's note: The date might be in error; the sighting is most likely to have occurred on Nov. 9 and not on Nov. 10. 5) Maximum wind velocities were as follows: Wilmington, N.E. 40 mph; Kittyhawk, N.E. 58 mph; Hatteras, N.W. 49 mph; Norfolk, N.E. 34 mph; all of the above occurred on Nov. 8. The maximum wind velocity at Nantucket was N.E. 40 mph on Nov. 9, and it was N.E. 50 mph at Block Island on Nov. 10 (Monthly Weather Review, Nov. 1893). 6) Track for this storm as follows: Nov. 6 (evening), lat. 28 N., long. 73.3 W.; Nov. 7 (morning), lat. 30 N., long. 74.5 W.; Nov. 7 (evening), lat. 32 N., long. 75.3 W.: Nov. 8 (morning). lat. 34.5 N., long. 75.3 W.; Nov. 8 (evening), lat. 36.5 N., long. 73.7 W.; Nov. 9 (morning), lat. 38.3 N., long. 71.3 W.; Nov. 9 (evening), lat. 40 N., long. 68.5 W.; Nov. 10 (morning), lat. 40.5 N., long. 60.5 W.; Nov. 11 (morning), lat. 40.5 N., long. 50 W.; Nov. 12 (morning), lat. 40.5 N., long. 41 W. (Monthly Weather Review, Nov. 1893).

The track shown in Neumann et al. (1993) was not found to agree with the information in most of the items above and, therefore, the author of this sudy decided to prepare a new track for Storm 12, 1893. The author's track was started with an estimated position near 27.0 degrees N., 72.5 degrees W. at 7 A.M. Nov. 5; this position was based on information in item 1) and was

about 600 miles to the N.E. of the corresponding position in Neumann et al. (1993). The author's 7 A.M. Nov. 6 position was near 28.0 degrees N., 74.5 degrees W. and was based on information in items 1) and 6) and on space-time continuity; such a position was about 300 miles to the N.N.E. of the corresponding one in Neumann et al. (1993). The author's 7 A.M. Nov. 7 position was estimated near 30.5 degrees N., 75.7 degrees W.and was also based in items 1) and 6); this position was about 150 miles to the N.N.E. of the corresponding one in Neumann et al. (1993). The author's 7 A.M. Nov. 8 position was near 34.5 degrees N., 75.3 degrees W., coincided with the one given in item 6) and was about 30 miles to the N.E. of the one given in Neumann et al. (1993). The author's 7 A.M. Nov. 9 position was near 37.7 degrees N., 71.3 degrees W. and was primarily based on information in item 6); this position was about 100 miles to the N.E. of the corresponding one in Neumann et al. (1993). Based on information in item 6) and to a much lesser extent in item 1), the author of this study estimated 7 A.M. positions near 40.0 degrees N., 60.5 degrees W. for Nov. 10 and near 41.0 degrees N., 49.0 degrees W. for Nov. 11; his 7 A.M. Nov. 12 position near 41.0 degrees N., 40.5 degrees W. was estimated on the basis of information in item 6). The author's track for Storm 12, 1893 is displayed in Fig. 3.

As no hurricane winds were reported in the above items, the tropical storm status given to this storm in Neumann et al. (1993) seems to be satisfactory. However, some subtropical characteristics might have been present even in the early stages of this system. The storm should have quickly lost any tropical character, having essentially become an extratropical system over the North Atlantic Ocean.

Special statement.

In addition to the storms fully discussed above, two possible cases were found for 1893. The available information related to these sases was not sufficient to determine the nature of the disturbances and/or to obtain a verification of their tracks.

A) Case of May 12-13, 1893.

The following information was found about this possible case: 1) During May 12-13 a storm advanced W. of N. from the region E. of the Bahamas and united with a low pressure area near the south New Englad coast (Monthly Weather Review, May 1893). 2) Track for the possible case as follows: May. 12, near lat. 26 N., long. 67.5 W.; May 13, near lat. 36 N., long. 69 W; ended near lat. 40.3 N., long. 72.3 W. (Monthly Weather Review, May 1893). The author of this study believes that the use of the word storm in reference to this system does not necessarily imply that it had tropical characteristics or really reached storm intensity. Therefore, he decided to keep this system as a possible case.

B) Case of Jul. 6, 1893.

The following information was found about this possible case:

2) A destructive whirlwind crossed eastern Cuba the evening of Jul. 6. The storm struck the island at Santiago de Cuba at 8:30 P.M. and at that place the wind shifted from S.S.E. to N.N.E and blew with great fury. It passed thence N. of E. to a point W. of Baracoa and there recurved and passed inside the N.N.E. coast to a point W. of Banes where it passed to sea. A schooner was wrecked off Santiago de Cuba and in the district about Banes 10,000 acres of banana plants and property valued at $ 200,000 were destroyed (Monthly Weather Review, Jul. 1893). This system seems to have moved over 60 miles, which is the distance between Santiago de Cuba on the southern Cuban coast and Banes on the northern coast. It could have been a tornadic wortex or, perhaps more likely, a small tropical cyclone which developed in the general environment associated with Storm 2, 1893. However, neither Sarasola (1928) nor Martinez-Fortun (1942) mentioned any cyclone to have occurred in Cuba in 1893. Because of the above uncertainty, the author of this study decided to to keep this one as a possible case.